Subtleties of NP effects in event shapes (work 10 years ago with Daniel Wicke)

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We all know that parton level is not well-defined. It depends what went into the partonic calculation.

MCs: impact of low-p_t cutoff

NNLO/N^{n}LL: integration into IR, renormalons

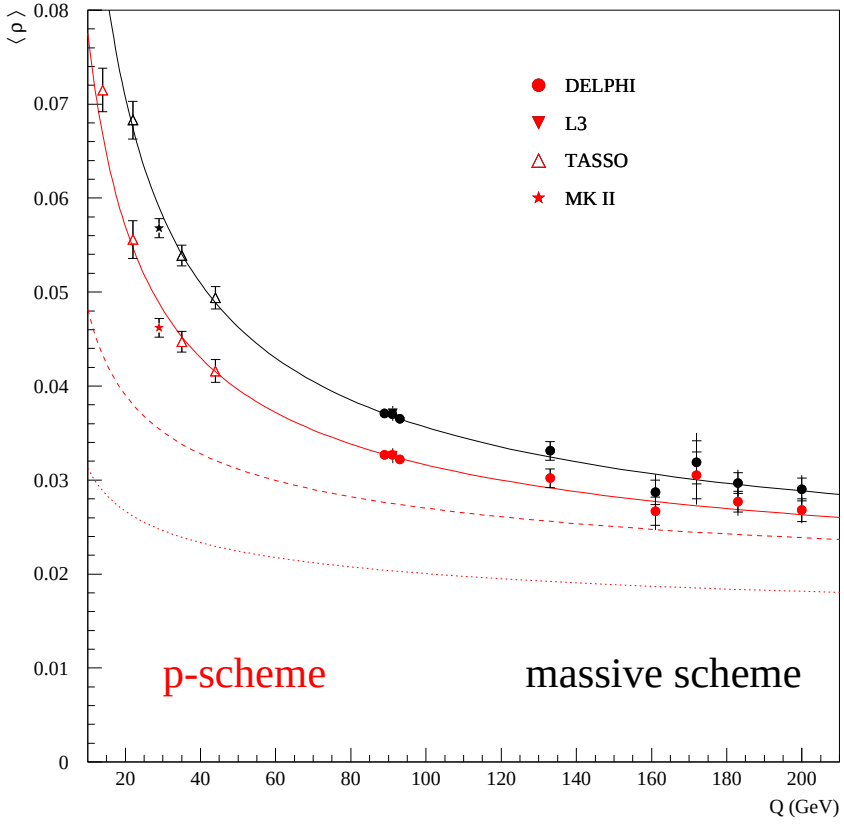
But we musn't forget that hadron level has its ambiguities too:

- Which hadrons do you mean?
  - "Resonance level", at a few hundred fermi from interaction point?
  - Default hadron-level: at a few meters from IP?
  - Fully decayed: at ∞?
- Purely partonic calculations (and renormalon calcs) know nothing about hadron decays; nor about differences between E and $|\vec{p}|$

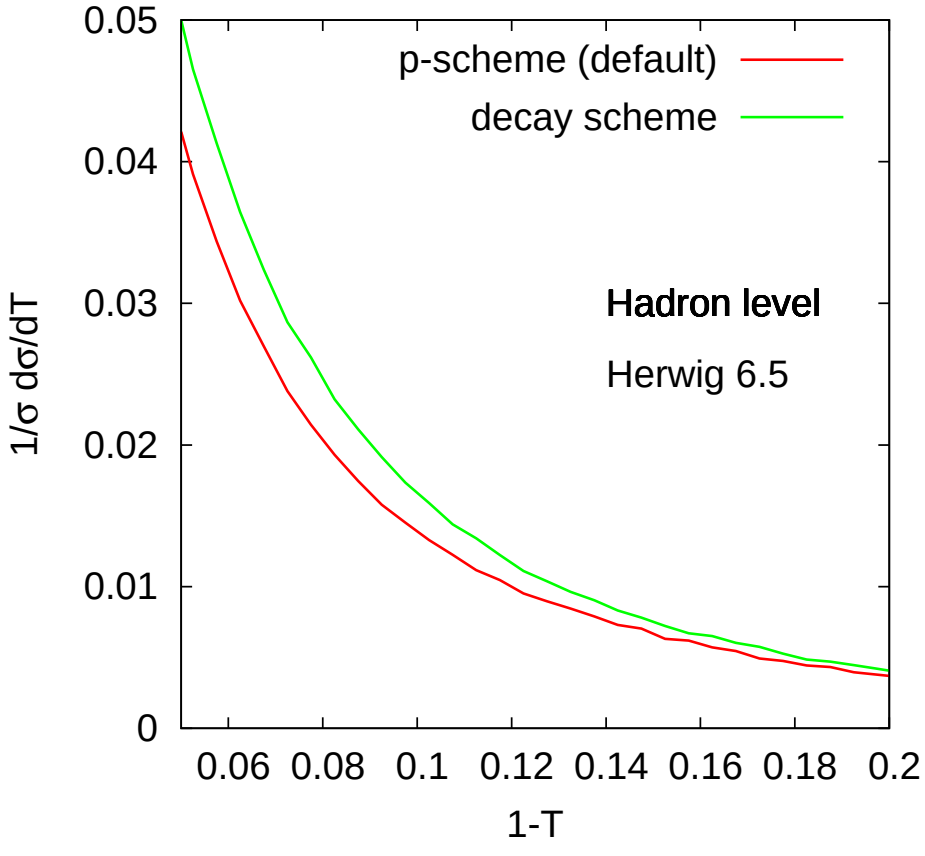
Hadrons are massive, partons are not

Hadron mass effects are significant

$\langle$ Heavy Jet Mass $\rangle$ v. Q

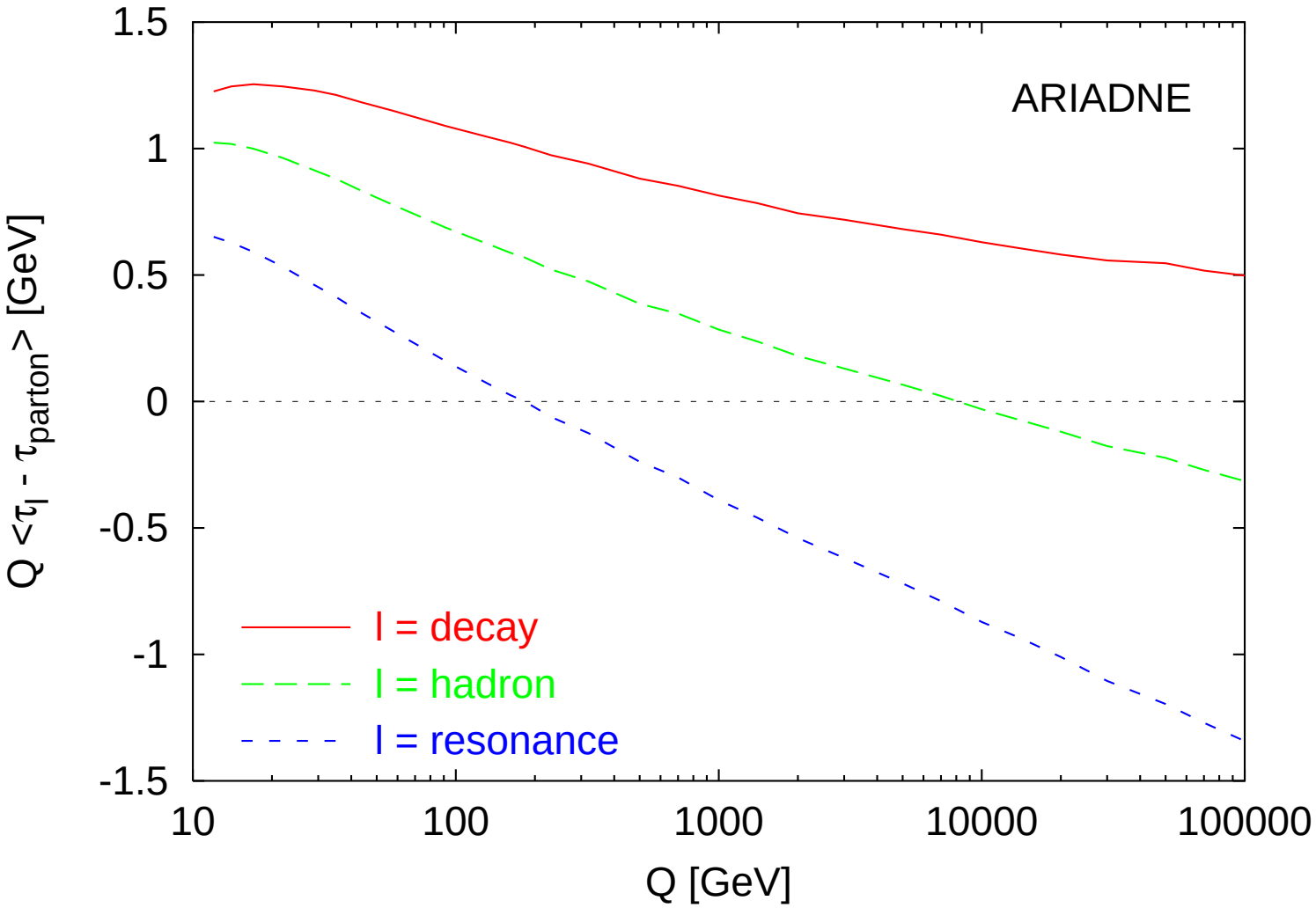


Thrust distribution ($Q = M_Z$)



MC thrust hadronisation not just $1/Q$

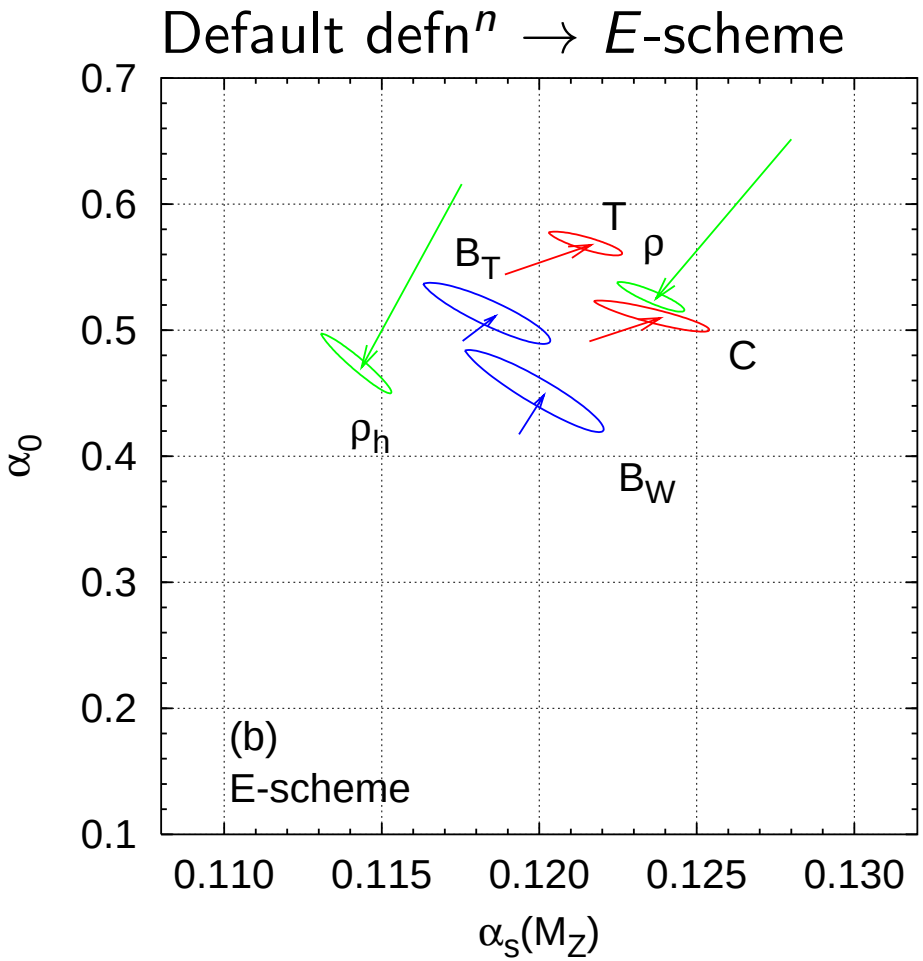
Λ/Q is a good first approximation. But there are anomalous dimensions, and their impact depends on what hadron level you use.

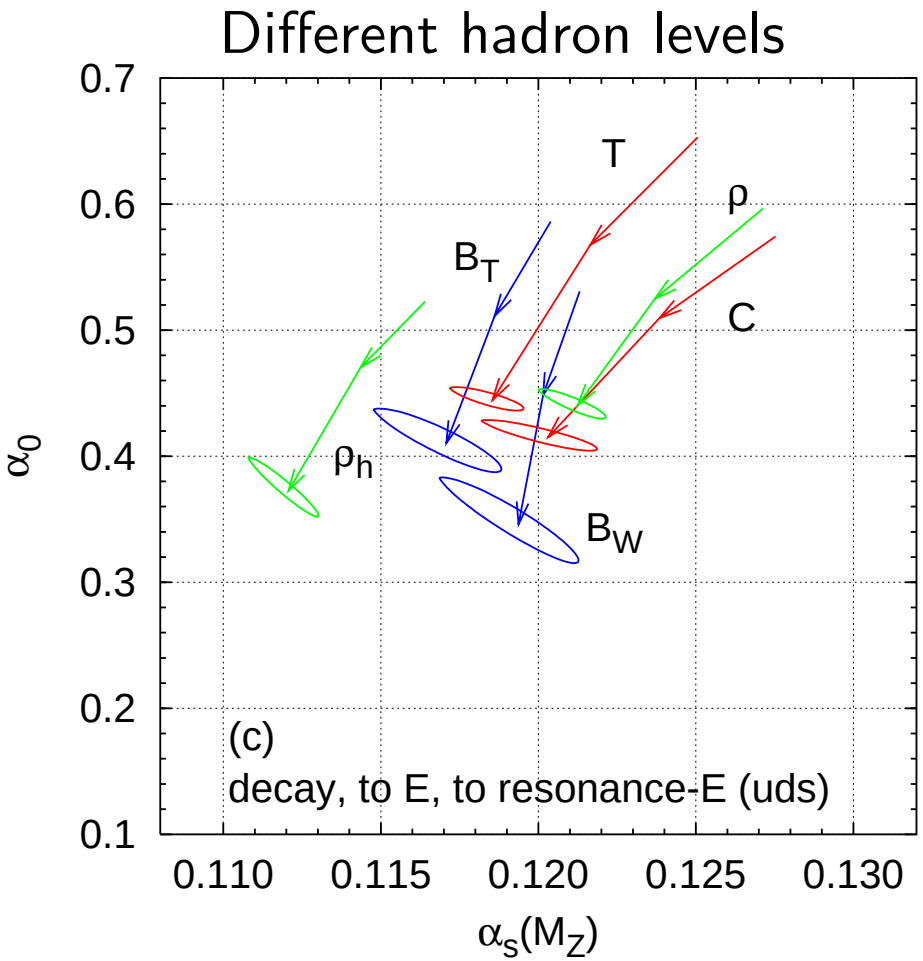


Power correction fits to $\langle$event-shapes$\rangle$

If your fit has degeneracies in the $\alpha_0 - \alpha_s$ plane, then a mis-parametrised non-perturbative part will translate to a systematic error on α_s.

Below: NLO + $1/Q$ - double counting, à la Dokshitzer-Webber





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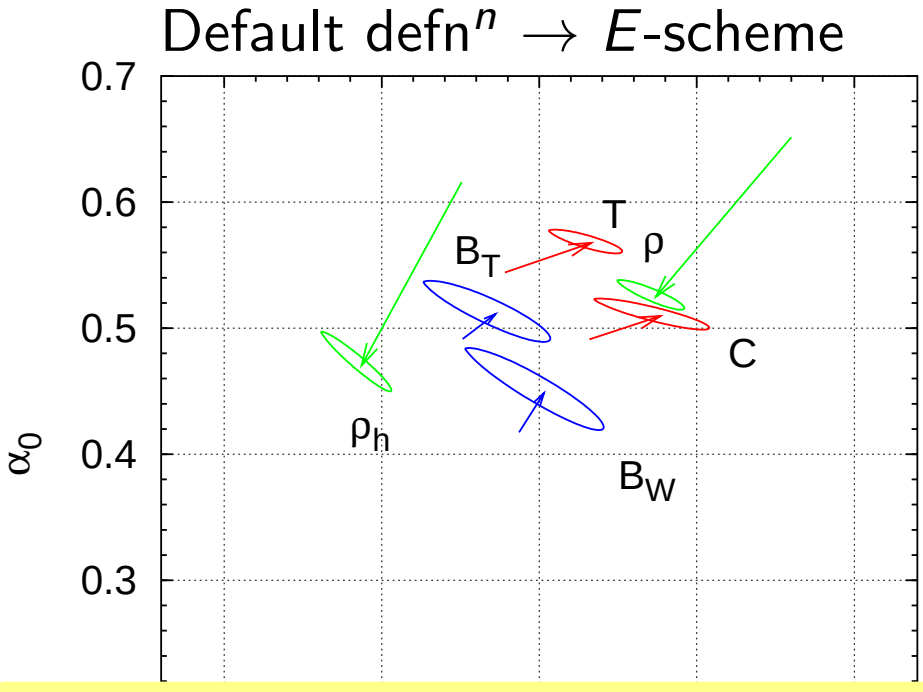
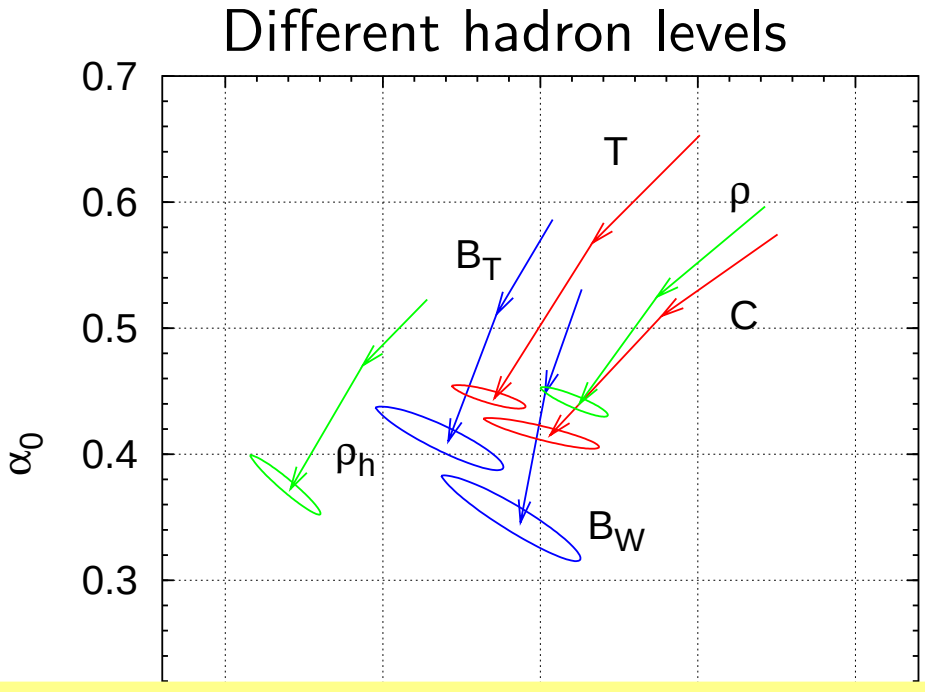




For fits to distributions, this may matter less than in fits to mean-values (cf. Gardi & Rathsman found only 1.5% effects).

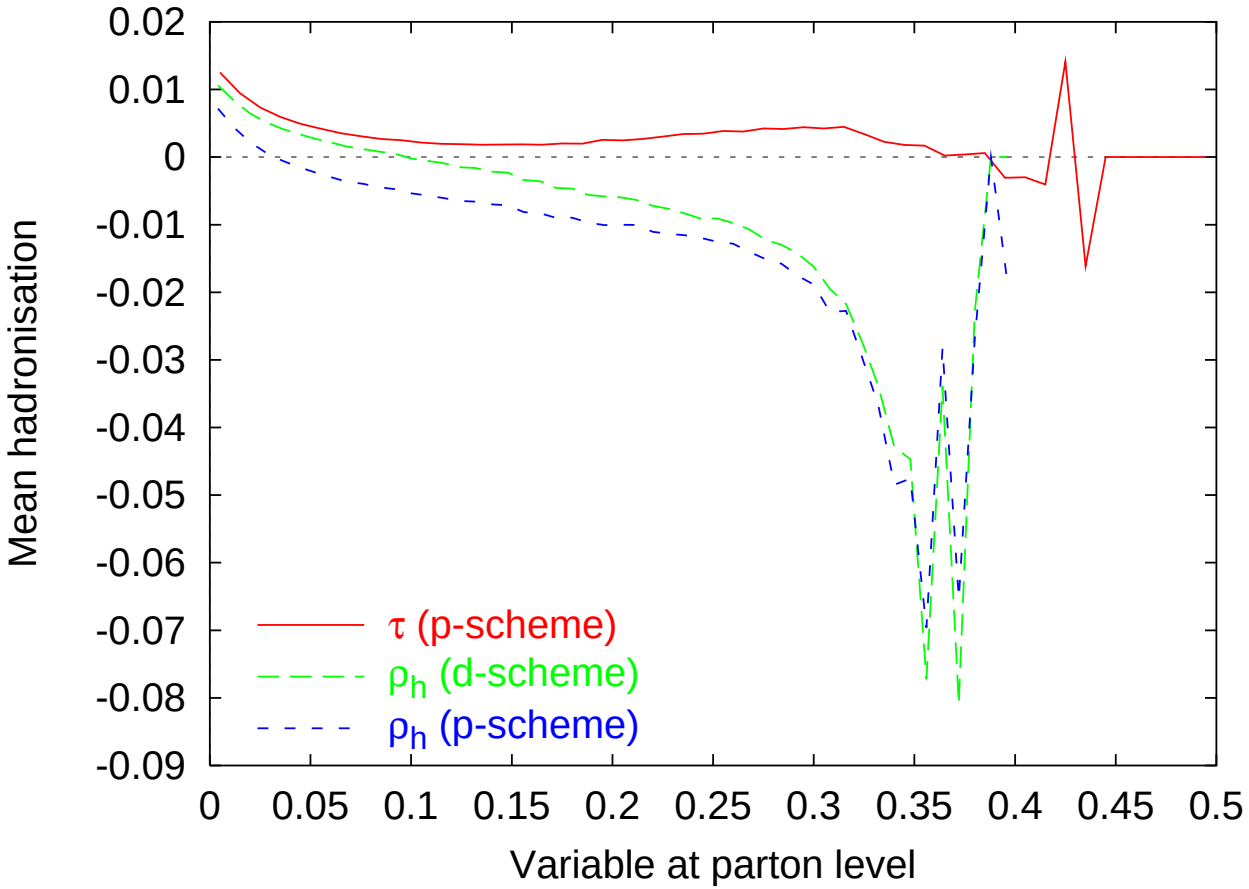
It depends on how critical Q-scaling is to resolving $\alpha_s - \alpha_0$ degeneracy.

Another subtlety: V dependence

MC tells us that NP correction to thrust/ρ_h/etc. is *not* necessarily independent of value of thrust/ρ_h/etc.

Many fits *assume* that it is independent. (Don't know how to do better)

Except, partially, for jet broadenings; thrust in SCET?



Trade bad modelling of NP $\leftrightarrow$ modified α_s

$\Rightarrow$ unquantified systematic errors on α_s, that are especially severe in fits to distributions.

Is there a way out?

Can we really measure α_s accurately from e^+e^- events shapes?

Without ILC...

So far I'm not sure I'm convinced we can.

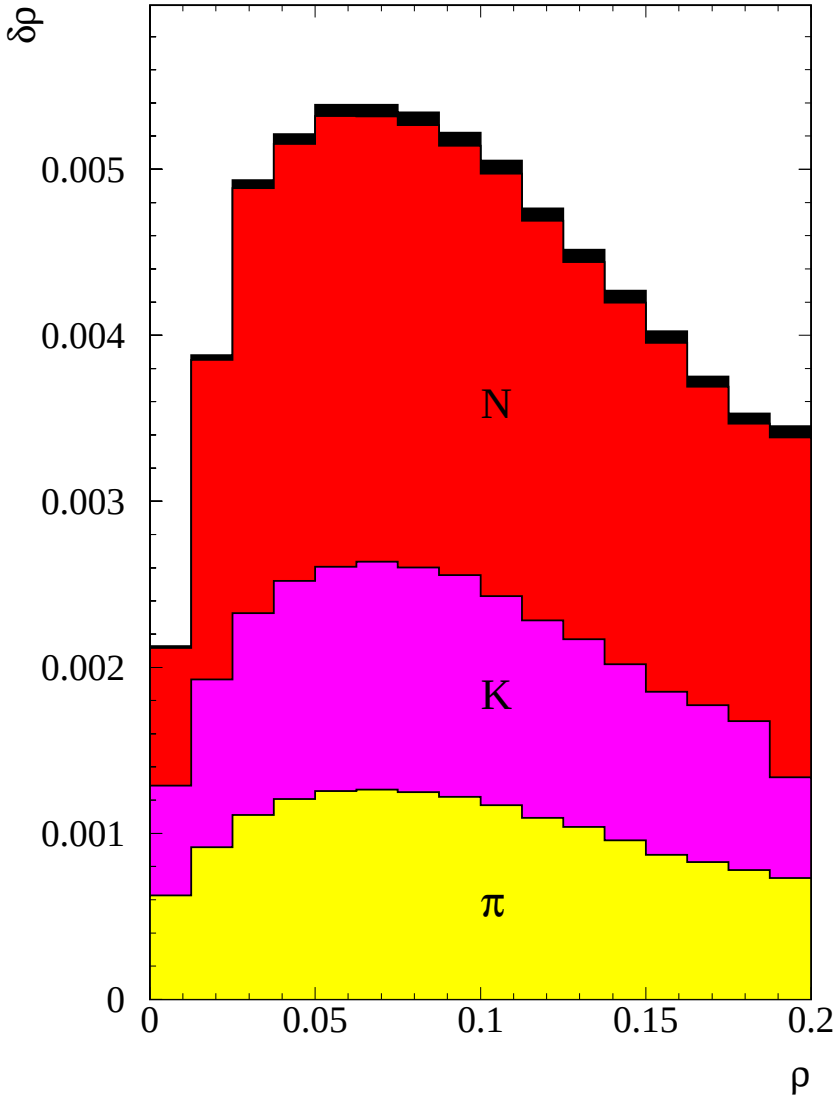
Despite having (because I've) played these games myself

Examining different "hadron-levels" can help stress-test the assumptions of analytical hadronisation models.

But, a fit to just a single event shape (e.g. thrust) may still be subject to important systematics that remain hidden until you study multiple event shapes...

EXTRAS

Massive–p-scheme breakdown



Hadron mass effects